Testing Guideline on the Degradability and Food Safety of Containers and Bags

Part 1: General Guide and Specifications

This Testing Guideline is developed to evaluate the degradability and food safety of containers and bags. The Guideline includes two parts. Part 1 gives the background, scope and technical specifications for degradable containers and bags. Part 2 describes the details of the testing methods for three main aspects: food safety, degradability and physical performance.

Objective

This Testing Guideline is developed to set out the acceptance criteria and the corresponding testing methods for degradable containers and bags.

Background

According to the survey "Monitoring of Solid Waste in Hong Kong"[1] conducted by the Environmental Protection Department in 1999, plastic materials accounted for about 19.4% of the total weight of municipal solid waste disposed of. Amongst the plastic wastes, plastic bags and expanded polystyrene (EPS) products (e.g. food /drink containers and packaging materials) were most significant. Disposal of these plastic materials at landfills will create environmental problems as they would not decompose.

Recently, some so called 'biodegradable' or 'photodegradable' plastic bags and food/drink containers are available in the market. However, a study on three different brands of biodegradable food containers [2] found that two of them were neither biodegradable in soil and water environment nor photodegradable under UV irradiation. More importantly, these food containers could only be used for dry food as a significant amount of substance was released from the container when it was wet. To verify the performance of these products, specifications and standard testing methods have to be established. Testing methods for products on biodegradability and photodegradability have been developed by some well known organizations such as the American Society for Testing and Material (ASTM), International Standardization Organization (ISO), Japan Industrial Standards (JIS), and China National Testing Standards (GB), etc. Although these testing methods cover comprehensive testing procedures for the biodegradability and photodegradability of plastic materials, the testing conditions may not be suitable for use in Hong Kong. The following Testing Guideline is developed with reference to international testing standards but modified to suit the Hong Kong environment.

Scope of Evaluation

There are two main aspects for evaluating the degradable containers and bags, namely food safety and degradability. In addition, the physical performance of the degradable products can be evaluated by the prescribed testing methods. The details of the testing methods are shown in Part 2 of this Guideline.

1. Food Safety

   Containers and bags used for containing food or drink are required to meet certain hygienic requirements. These products would be evaluated by means of an Overall Migration Test, a Heavy Metals Test, a Pesticide Residues Test, a Coliform Test and a Moulds and Yeasts Test. In the Overall Migration Test, the quantity of substances, which have migrated to the food simulant, would be determined. The migration of heavy metals would be determined in similar procedures but acetic acid is used instead of a food simulant. The migration level is not permitted above a pre-defined safety level. The existence of pesticides in the test sample will also be examined since some of the degradable food containers may be made from plant fibre (e.g. sugar cane fibre). Also, the hygienic standard of the containers and bags can be indicated by the amount of coliform bacteria and moulds, which exist in the containers and bags.

2. Degradability

   Biodegradable products can be tested by incubating them in an aerobic composting environment. Biodegradability of the products is determined by measuring the carbon dioxide emitted from the test samples during the incubation period. Mixtures of test samples and municipal solid waste are incubated in a composting vessel at a steady test temperature. Biodegradation of the samples will finally convert the organic carbon into carbon dioxide. The carbon dioxide content of the samples emitted from the composting vessel is used to calculate the degree of biodegradation of the samples. Degradable containers or bags are expected to have a certain degree of biodegradation within the incubation period.

3. Physical Performance

   Degradable containers are tested with five physical performances: static loading, fold resistance, low temperature resistance, oil and water proof at raised temperature and acid resistance. These tests are used to evaluate the performance of the products when used. For example, the static loading test is used to simulate the actual application when several food containers are piled up for delivery. The low temperature resistance test will simulate the condition when the container is placed in a refrigerator for temporary storage of food. It is important for a container to have sufficient physical performances for its ultimate use. The physical performance criteria are compared with those of EPS food containers.

   Physical requirements for degradable bags vary depending on their ultimate use. For example, heavy-duty bags require higher tensile strength than those for normal use. The tensile strength testing method is described in Part 2.

Criteria for Degradable Containers and Bags

1) Tests Required

Degradable containers and bags are classified into four categories depending on their use:

i) Degradable food/drink containers (DFC);

ii) Degradable non-food containers (DNFC);

iii) Degradable food bags (DFB);

iv) Degradable non-food bags (DNFB).

It is not necessary for a degradable container (or bag) to be tested for all the criteria as described earlier. For example, it is pointless to test the food safety of a container that will not be used for food handling. For food containers, the food safety test is of prime importance. Table 1 summarizes the criteria that need to be evaluated for the above four product categories.

Table 1: Tests required for each category of degradable containers and plastic bags.

Performance	DFC	DNFC	DFB	DNFB
1. Food Safety				
● Overall migration test: total immersion method / article filling method	□		□	
● Heavy metals test	□		□	
● Pesticide residues test	□		□	
● Coliform bacteria test	□		□	
● Moulds and yeasts test	□		□	
2. Degradability				
● Biodegradability	□	□	□	□
3. Physical Performance				
● Static loading test	—	—		
● Fold resistance test	—	—		
● Water and oil proof tests at raised temperature	—	—		
● Low temp resistance test	—	—		
● Acid resistance test	—	—		
● Tensile strength test			—	—

Note : □ = must satisfy the passing criteria

— = for reference only

Sampling

If the purpose of testing is for an entry in the Registration Scheme administered by EPD, all tests should be conducted in accordance with the sampling method described in the Registration Scheme. In any case, sample testing should be conducted in **triplicate** unless otherwise specified.

Passing criteria

Table 2 lists out the passing criteria for each specified test. Samples claimed to have specific performance should meet the passing criteria of the correspondence tests.

Table 2: Passing criteria for different tests

Performance	Test Method	Page Number	Criteria
1. Food safety			
Overall migration test by total immersion or article filling	HS 1001 or HS 1002	HS 1001-1 HS 1002-1	
- Distilled water simulant			≤ 10 mg/dm^2 or 60 mg/kg
- Acetic acid simulant			≤ 10 mg/dm^2 or 60 mg/kg
- Ethanol simulant			≤ 10 mg/dm^2 or 60 mg/kg
Heavy metals test	HS 1003	HS 1003-1	
- Cadmium			≤ 3 ppb (method detection limit 0.5 ppb)
- Chromium			≤ 50 ppb (method detection limit 1 ppb)
- Lead			≤ 10 ppb (method detection limit 2 ppb)
- Mercury			≤ 1 ppb (method detection limit 0.5 ppb)
Pesticide residues test	HS 1004	HS 1004-1	(method detection limit 1 ppb)
Organophosphate pesticide			
- Dichlorvos			≤ 1 ppb
- Dimethoate			≤ 1 ppb
- Fenitrothion			≤ 1 ppb
- Fenthion			≤ 1 ppb
- Malathion			≤ 1 ppb
- Parathion			≤ 1 ppb
- Phorate			≤ 1 ppb
Organochlorine pesticide			
- Aldrin			≤ 1 ppb
- BHC			≤ 1 ppb
- DDT			≤ 1 ppb
- Dieldrin			≤ 1 ppb
- Heptachlor			≤ 1 ppb
Coliform bacteria test	HS 1005	HS 1005-1	must not be detected (method detection limit 10 colonies/100 g)
Moulds and yeasts test	HS 1006	HS 1006-1	≤ 50 colonies/g (method detection limit 1 colony/100 g)

Table 2: Passing criteria for different tests (con't)

Performance	Test Method	Page Number	Criteria
2. Degradability			
Biodegradability test - Incubated at 58 °C for 180 days - % conversion of organic carbon in the sample to CO_2	HS 2001	HS 2001-1	≥ 60% within 180 days
3. Physical performance			
Static loading test - subject to a pre-defined loading	HS 3001	HS 3001-1	Average deformation in height of three specimens ≤ 6 %
Fold resistance test***** - 15 times of folding and unfolding	HS 3002	HS 3002-1	No hinge breakage for at least two out of three test specimens
Low temperature resistance test - stored at – 25 °C for 4 hours	HS 3003	HS 3003-1	No breakage for at least two out of three test specimens
Water and oil proof tests at raised temperature - conditioned with 95 °C hot water and cooking oil	HS 3004	HS 3004-1	No abnormality, leakage, discoloration and defects for all three test `specimens
Tensile strength test	HS 3005	HS 3005-1	As specified by users.
Acid resistance test - conditioned with acetic acid for 2 hours	HS 3006	HS 3006-1	No discoloration, defects, distortion and leakage for all three test specimens

*Note: * Only for those containers with non-detachable lids.*

List of Testing Equipment

The major apparatus and analytical instruments to be used for testing are listed as follows:

1. Food safety

- Analytical balance with an accuracy of ±0.1 mg.
- Conditioning containers for conditioning test specimens at 50 % ± 5 % relative humidity and 80 % ± 5 % relative humidity at 20 °C ± 3 °C.
- Thermostatically controlled oven or incubator capable of maintaining a temperature of 40 °C ± 1 °C and 70 °C ± 2 °C.
- Chromatography tank or any other airtight container for storage of test samples.
- Steam bath or hot plate and distillation apparatus.
- Atomic absorption spectrometer/ICP-MS.
- Gas chromatography instrument.

- Membrane filter with a rated pore diameter.
- Incubators capable to maintain a temperature of 35 °C ± 0.5 °C and 60% relative humidity.
- Microscope.
- Autoclave for steam sterilization capable to operate at 121 °C and 100 kPa.
- Incubator capable of operating at 27 °C ± 2 °C.
- Rotary shaker.
- Stomacher.
- Blender.
- Laminar flow hood.
- Water bath for tempering agar.

2. Biodegradability

- Gas chromatography instrument.
- Water bath or other temperature controlling apparatus capable of maintaining the temperature of composting vessels at 58 °C ± 2 °C.
- pH meter.
- Analytical balance with an accuracy of ± 0.1 mg.
- Composting vessels, glass flasks or bottles that allow an even gas purge in an upward direction. A volume of 2 to 5 litres is required. Depending on the test material, a smaller volume may be used for screening purposes.

3. Physical Performance

- Analytical balance capable to measure 2 kg with a tolerance of 0.1 g.
- Low temperature chamber or freezer capable to maintain temperature down to – 25 °C or below.
- Conditioning oven capable to maintain a temperature of at least 100 °C with a tolerance of 3 °C.
- Tensile test machine capable to provide a constant rate-of-jaw-separation. The machine shall be equipped with a device for recording the tensile load and the amount of separation of the grips.
- Thickness gauge or a dead-weight dial micrometer capable to measure down to 0.0025 mm or less.

References

1. Major recyclable materials in domestic waste and C&I waste disposed of at waste facilities, Solid Waste Statistics for 1999, http://www.info.gov.hk/epd.
2. Jian Yu, F. Zhang, W. H. Lo, Po Lock Yu, “The Performance, Degradability and Material Property of Disposable Plastic Food Containers”, Environmental Protection Department, HKSAR Government, 1999.
3. John K. O. Chung, ‘Monitoring of Solid Waste in Hong Kong 1998”, Facilities Planning Group, Environmental Protection Department, HKSAR Government, 1999.